IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: Lawrence K. Lam, et al. Attorney Docket No: 18180.0023 #11

Application No.: 09/604,662 Group Art Unit: 2877

Filed: June 27, 2000 Examiner: S. Turner

For: DUAL ELECTROOPTIC WAVEGUIDE INTERFEROMETER

S. Lange 2/12/03

APPEAL BRIEF UNDER 37 C.F.R. § 1.192

Assistant Commissioner For Patents
Washington, D.C. 20231

Dear Sir:

Appellants file herewith an Appeal Brief in connection with the above-identified application, wherein claims 1-24 were finally rejected in the Office Action of August 30, 2002. The following is Appellants' Appeal Brief in accordance with 37 C.F.R. § 1.192(a):

I. REAL PARTY IN INTEREST

The real parties in interest in this appeal include the inventors named in this application: Lawrence K. Lam and Timothy E. Van Eck. As assignee, Lockheed Martin Corporation is also a real party in interest.

II. RELATED APPEALS AND INTERFERENCES

There are no appeals or interferences known to Appellants, the assignee, or the legal representative which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

III. STATUS OF CLAIMS

The status of all the claims in the application are as follows:

Claims	Status
1-24	Rejected

This appeal is directed to claims 1-24.

IV. STATUS OF AMENDMENTS

After receiving the final Office Action having a mailing date of August 27, 2002, Appellants submitted a Response to the Office Action on October 21, 2002. In the Response, Appellants provided remarks addressing the Examiners rejections of claims 1-24 in the final Office Action. In an Advisory Action having a mailing date of November 1, 2002, the Examiner stated that he would only enter the Response if an appeal is filed.

No other amendments after final have been submitted.

Accordingly, Appellants consider the status of the claims to be as they were in the Response to Office Action dated October 21, 2002.

V. SUMMARY OF INVENTION

As described in the specification on page 4, the present invention comprises a new interferometer referred to herein as a Dual Electrooptic Waveguide Interferometer (DEWI). In a preferred embodiment, the present invention comprises two optical waveguides that are electrooptically modulated by separate electrodes. The outputs of the waveguides are combined by diffraction, and in the process create an interference pattern. This pattern is created in the Fraunhofer region in one embodiment, and it is located within the Fresnel zone in another embodiment. The interference pattern is captured by an optical system and projected onto an array of photo detectors.

The locations of the nulls in the interference pattern as detected by photo detectors are used to estimate the optical phase difference between the outputs of the waveguides. The phase difference is a function of the amplitude of the electrical signals applied to a pair of electrodes, which control the refraction indices in the waveguides.

A basic version of the DEWI interferometer uses an integrated optical splitter at the front end. A simpler variant of it does not contain an optical splitter. Instead it accepts the optical signals as separate inputs, and measures the phase difference between them, under the control of the voltages applied to the electrooptic electrodes. This variant could be used to estimate a variable, beside the electrooptic voltages, that affected the relative phase of the optical inputs.

FIG. 2 depicts a dual electrooptic waveguide interferometer (DEWI) 200 according to a preferred embodiment of the present invention. As described in the specification on page 6, lines 21-27, interferometer 200 operates by detecting the location of the null of the interference pattern on the photo detector array 236. Interferometer 200 receives an optical signal 202 from an optical source, such as laser 204. Interferometer 200 also receives two electrical signals 206 and 208. Signal 206 is a reference voltage. Signal 208 is a data input signal to be processed.

As described in the specification on page 7, lines 5-22, interferometer 200 includes a reference electrode 210 and a RF input electrode 212. Electrodes 210 and 212 receive electrical signals 206 and 208, respectively. Interferometer 200 also includes a plurality of waveguide components. Input section 214 receives optical signal 202 and feeds it to an optical divider 216, which splits the signal between two modulation sections 218 and 220. Reference electrode 210 is substantially parallel to waveguide modulation section 218 in a traveling wave modulator configuration that is well-known in the relevant arts. Similarly, RF input electrode 212 is substantially parallel to waveguide modulator section 220 in a traveling wave modulator configuration. The modulated optical signals leave the exit apertures of waveguides 218 and 220 as optical signals 226 and 232, respectively.

On exiting, optical signals 226 and 232 enter a diffraction section 234 where they interfere to create an interference pattern upon a photo detector array 236. Photo detector array 236 is comprised of a series of photo detector elements. The interference pattern that falls on photo detector array 236 is a function of λ_o (the free-space optical wavelength), d (the separation between the waveguide exit apertures), L (the distance from the exit apertures to the photo detector array), and the voltages applied to electrodes 210 and 212. Applying voltages to electrodes 210 and 212 affects the optical phases of the optical signals in the associated waveguides, and hence the output interference pattern. In a preferred embodiment, a decoder 238 is employed to convert the interference pattern to a digital signal 240.

VI. ISSUES

I. Has the Examiner established that claims 20 and 24 are anticipated by U.S. Patent No. 4,747,688 to Geary ("Geary") under 35 U.S.C. §102(b)?

II. Has the Examiner established that claims 1-6, 13, 14, 16, 17, and 21-23 are unpatentable over the prior art of Figure 1 in view of U.S. Patent No. 5,172,185 to Leuchs ("Leuchs") under 35 U.S.C. §103(a)?

III. Has the Examiner established that claims 7-12, 15, 18, and 19 are unpatentable over Leuchs as applied to claims 1-6, 13, 14, 16, 17, and 21-23, and further in view of Geary under 35 U.S.C. §103(a)?

VII. GROUPING OF CLAIMS

Claims 1-24 stand or fall together.

VIII. ARGUMENT

THE REJECTIONS UNDER 35 U.S.C. § 102(b)

At page 2 of the final Office Action, the Examiner rejected claims 20 and 24 under 35 U.S.C. §102(b) as being anticipated by Geary. In support of the rejection, the Examiner asserts that claims 20 and 24 are clearly anticipated by Figures 1 and 2 of Geary. However, contrary to the Examiner's assertion, Geary measures optical coherence between two signals. Optical coherence is a statistical measurement. In other words, the measurement inherently requires an averaging or integration process. The measured result is called the visibility (col. 5, lines 30-47).

The statistical measurement in Geary, referred to as the visibility, produces a value that varies between zero and one. A value of zero means the two optical signals are totally incoherent with respect to each other. In other words, the optical signals are statistically independent from each other. A value of one means that the two optical signals are completely coherent with respect to one another. In other words, the optical signals are perfectly phase locked together. However, Geary does not teach a method or apparatus for determining the phase difference between the two signals.

For example, assuming two optical signals are completely coherent with respect to one another, Geary's invention would make a measurement and produce a visibility (i.e., a statistical measurement) of one of the signals. However, even though the two optical signals are completely coherent, the phase difference between the two signals could vary between –180 to +180 degrees.

Because the visibility inherently requires an averaging or integration process, Geary indicates that detectors A and B may comprise any readily known an commercially available light detector such as film, CCD arrays, video cameras, etc. These detectors are commonly used to perform relatively slow measurements, for example, within a range of milli-seconds to seconds. These time spans are compatible with the nature of making a statistical measurement such as optical coherence, as taught by Geary.

In contrast to Geary, the applicants invention, as recited in claims 20 and 24, measures the phase difference between two input optical signals at a particular instance in time. This is completely different from and contrary to the calculation of visibility taught by Geary. In addition, the claimed invention is capable of making measurements at extremely high speeds, for example, 10 billion times a second. Such a result is not possible following Geary's teachings.

As recited in claim 20, the applicants invention detects the location of a null of an interference pattern and produces an output signal based on the location of the null. In contrast, Geary's invention is based on two detectors, A and B. Detector A is translated to the dark fringe and detector B is translated to the light fringe. The detectors measure the intensity of each signal, which is then used to calculate the visibility. In contrast to claim 20, Geary does not teach measuring the location of the null of an interference pattern.

To anticipate the claims, Geary must teach each and every element of the claims arranged as in the claims. Geary does not teach measuring the phase difference between two optical signals or measuring the location of the null of an interference pattern. Accordingly, the applicants respectfully submit that claims 20 and 24 are patentable and request reversal of the rejection of claims 20 and 24 under 35 U.S.C. §102(b).

<u>THE REJECTIONS UNDER 35 U.S.C. § 103</u>

The Rejection Based on Figure 1 in view of Leuchs

At pages 2 and 3 of the final Office Action, the Examiner rejected claims 1-6, 13, 14, 16, 17, and 21-23 under 35 U.S.C. §103 as being unpatentable over the prior art shown in Figure 1 in view of Leuchs. The Figure 1 device is an apparatus for measuring an unknown input voltage differentially applied across electrodes 106 and 108. The Figure 1 device operates by detecting the intensity, I, of the optical signals modified by electrodes 106 and 108.

Leuchs does not suggest a device for determining a phase difference between two signals. Instead, Leuchs describes a device for determining the wavelength of coherent light based on two optical waveguides. The detection of the wavelength of the coherent light is accomplished by using a set of photo detectors to detect an interference pattern generated by the output of two point light sources. However, the claimed invention uses a pair of electro-optic waveguides. In the claimed invention, the electro-optic waveguides comprise an optical waveguide and an electrode substantially parallel to the optical waveguides. Each of the electrodes functions to modulate the signal travelling through the optical waveguide.

Leuchs does not suggest the use of electrodes substantially parallel to optical waveguides. The claimed electro-optic waveguide is significantly different from the optical waveguides shown in Leuchs because the claimed electro-optic waveguide modulates the optical signal travelling through the optical waveguide. Leuch's does not suggest the modulation of the optical signals. Thus, the prior art of Figure 1 and Leuchs do not suggest either the claimed invention or combining their respective techniques. This cited art therefore does not support the Examiner's assertions and basis for the rejection of claims 1-6, 13, 14, 16, 17, and 21-23. Applicants respectfully request reversal of the rejection of claims 1-6, 13, 14, 16, 17, and 21-23 under 35 U.S.C. §103.

The Rejection Based on Leuchs in view of Geary

At page 3 of the final Office Action, the Examiner rejected claims 7-12, 15, 18, and 19 under 35 U.S.C. §103 as being unpatentable over the prior art shown in Figure 1 and Leuchs as applied to claims 1-6, 13, 14, 16, 17, and 21-23, and further in view of Geary.

Leuchs teaches a device that measures wavelength. To do this, Leuchs' device uses two interferometers (8 and 12). The first interferometer 8 is used to determine the optical wavelength in the measurement chamber. This first interferometer 8 generates a signal that is fed back to the optical source so that the wavelength in the measurement chamber is stabilized. The second interferometer 12 is used to measure a length that is determined by the position of the triple mirror 11.

In Leuchs design, it is implied that the optical power is sufficiently high. Therefore, the sensitivity of the length measurement would depend on the size of the interference pattern that could be produced by the first interferometer 8. A large interference pattern is preferred for

higher sensitivity or stability. Figures 3 and 4 illustrate two arrangements to achieve this large interference pattern.

In the applicants invention, the terminal portions of waveguides 218 and 220 (Figure 2) are separated by, for example, more than 20 microns. The waveguides 218 and 220 are positioned at an angle with respect to each other. This angle is designed to produce a real image at a plane a predetermined distance from the exit apertures. For a slant of, for example, 0.1 radians, the interference pattern is taken from a plane 250 microns away.

The interference pattern is formed by Frensel diffraction, which occurs by design in the near field of the optical fields at the exits of waveguides 218 and 220. The "focal point" referred to in claim 8 of the applicants invention refers to a focal point due to Frensel diffraction. The purpose of the lens assembly, as stated in claim 7, is to magnify the interference pattern, which is tightly packed spatially. The tightly packed interference pattern, which has very few peaks and nulls, is then projected onto an array of discrete photodetectors.

The interference pattern used in the applicants invention is in direct contrast to Leuchs interference pattern. Clearly, in Figures 3 and 4, Leuchs teaches waveguide arrangements that produce interference patterns that are widely spread out. The spread out interference pattern is completely different from the applicants tightly packed interference pattern.

As a basis for rejection, the Examiner has also stated that the use of a Rotman lens, as stated in claim 11, would have been obvious to one of ordinary skill in the art. However, in the applicants invention, an optical Rotman lens, shown in applicants Figure 7, works in a manner that is not obvious. The Rotman lens is not used to focus a group of signals into a few signals. Rather, the Rotman lens in the applicants invention is used to separate and distribute an optical interference pattern to a finite number of photo-detectors. The Rotman lens in the applicants invention is used in a non-conventional manner, and therefore would not have been obvious to those skilled in the art.

Additionally, Geary does not overcome the deficiencies of the cited art discussed with respect to the rejections of claims 1-6, 13, 14, 16, 17, and 21-23. Thus, for the reasons stated above, applicants respectfully request reversal of the rejection of claims 7-12, 15, 18, and 19 under 35 U.S.C. §103.

CONCLUSION

All claims are believed to be in condition for allowance. If the Examiner believes that the present amendment still does not resolve all of the issues regarding patentability of the pending claims, Applicants invite the Examiner to contact the undersigned attorneys to discuss any remaining issues.

The Commissioner is hereby authorized to charge any insufficient fees or credit any overpayment associated with this application to Deposit Account No. 19-5127, Order # 18180.0023.

Respectfully submitted,

SWIDLER BERLIN SHEREFF FRIEDMAN, L.L.P.

Dated: February 6, 2003

By: John P. Moran

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APPENDIX A – CLAIMS

1. An apparatus comprising:

a first optical waveguide producing a first optical output;

a first electrode substantially parallel to the first waveguide;

a second optical waveguide producing a second optical output;

a second electrode substantially parallel to the second waveguide; and

a photo detector in the path of an interference pattern produced by the first and second optical outputs.

2. The apparatus of claim 1, wherein the photo detector detects the location of a null of the interference pattern.

3. The apparatus of claim 1, wherein the photo detector includes an array of photo detector elements.

4. The apparatus of claim 3, further comprising:

a decoder coupled to the photo detector array.

5. The apparatus of claim 4, wherein said first optical waveguide has an first input and said second optical waveguide has a second input, further comprising:

an optical divider coupled between the inputs of the first and second optical waveguides.

6. The apparatus of claim 5, further comprising:

an optical source coupled to the input of the optical divider.

7. The apparatus of claim 4, further comprising:

a lens assembly optically coupled between the outputs of the first and second optical waveguides and the photo detector array.

8. The apparatus of claim 7, wherein the outputs of the waveguides are angled towards each other to produce a focal point.

9. The apparatus of claim 8, wherein each of said waveguides has an output port, wherein the lens assembly comprises:

a magnifying lens optically coupled to the waveguide output ports;

a one-dimensional focusing lens coupled to the magnifying lens; and

a micro-lens coupled between the focusing lens and the photo detector array.

10. The apparatus of claim 9, wherein the lens assembly comprises a prism.

11. The apparatus of claim 7, wherein the lens assembly comprises an optical Rotman lens.

12. The apparatus of claim 11, wherein the optical Rotman lens has first and second inputs and multiple outputs, wherein the first and second inputs receive the outputs of the first and second optical waveguides, respectively, and wherein each element of the photo detector array receives one of the multiple outputs of the Rotman lens.

13. A method comprising:

electro-optically modulating a first optical signal using a first electrical signal;

electro-optically modulating a second optical signal using a second electrical signal; and

combining the first and second modulated optical signals in a diffraction region, producing an interference pattern.

14. The method of claim 13, further including:

detecting a null of the interference pattern.

15. The method of claim 13, wherein the diffraction region is a Rotman lens.

16. The method of claim 13, wherein the diffraction region is free space.

17. The method of claim 13, further comprising:

producing an output electrical signal based on the location of a null of the interference pattern.

18. The method of claim 17, wherein the interference pattern is detected by a photo detector array having multiple elements wherein each element of the photo detector array receives one of the multiple outputs of a Rotman lens.

19. The method of claim 18, further comprising:

generating the first and second optical signals using a laser and an optical divider.

20. A method of measuring an input signal, comprising:

producing an interference pattern based on the input signal;

detecting a location of a null of the interference pattern; and

producing an output signal based on the location of the null.

21. The method of claim 20, further including:

receiving a first electrical input signal;

electro-optically modulating a first optical signal using the first electrical signal;

combining the modulated first optical signal with a second optical signal to produce the interference pattern.

22. The method of claim 21, further including:

receiving a second electrical input signal;

electro-optically modulating the second optical signal using the second electrical signal; and

combining the modulated first and second optical signals to produce the interference pattern.

23. The method of claim 20, wherein the output signal is measured to determine an input voltage.

24. The method of claim 20, wherein the output signal is measured to determine the phase difference between two input optical signals.

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PTO/SB/21 (08-00)

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Approved for use through 10/31/2002. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	09/604,662
Filing Date	June 27, 2000
First Named Inventor	Lawrence K. Lam
Group Art Unit	2877
Examiner Name	S. Turner
Attorney Docket Number	18180.0023

Total Number of Pages in This Submission: 39

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ENCLOSURES *(check all that apply)*

- ☐ Fee Transmittal Form
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- ☐ Amendment / Response
  - ☐ After Final
  - ☐ Affidavits/declaration(s)
- ☐ Extension of Time Request
- ☐ Express Abandonment Request
- ☐ Information Disclosure Statement
- ☐ Certified Copy of Priority Document(s)
- ☐ Response to Missing Parts/ Incomplete Application
  - ☐ Response to Missing Parts under 37 CFR 1.52 or 1.53
- ☐ Statement Claiming Small Entity Status
- ☐ Drawing(s)
- ☐ Licensing-related Papers
- ☐ Petition Routing Slip (PTO/SB/69) and Accompanying Petition
- ☐ Petition to Convert to a Provisional Application
- ☐ Power of Attorney, Revocation Change of Correspondence Address
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- ☐ Request for Refund
- ☐ CD, Number of CD(s)
- ☐ After Allowance Communication to Group
- ☒ Appeal Communication to Board of Appeals and Interferences
- ☐ Appeal Communication to Group *(Appeal Notice, Brief, Reply Brief)*
- ☐ Proprietary Information
- ☐ Status Letter
- ☐ Other Enclosure(s) *(please identify below)*:

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm *or* Individual name	John P. Moran, Reg. No. 30,906
Signature	John P. Moran
Date	February 6, 2003

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FEE TRANSMITTAL for FY 2002

Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 320

Complete if Known	
Application Number	09/604,662
Filing Date	June 27, 2000
First Named Inventor	Lawrence K. Lam
Examiner Name	S. Turner
Group / Art Unit	2877
Attorney Docket No.	18180.0023

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METHOD OF PAYMENT (check all that apply)

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☒ Deposit Account:

Deposit Account Number	19-5127
Deposit Account Name	Swidler Berlin Shereff Friedman, LLP

The Commissioner is authorized to: *(check all that apply)*
☒ Charge fee(s) indicated below ☒ Credit any overpayments
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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	750	201	375	Utility filing fee	
106	330	206	165	Design filing fee	
107	520	207	260	Plant filing fee	
108	750	208	375	Reissue filing fee	
114	160	214	80	Provisional filling fee	

SUBTOTAL (1) ($) 0

2. EXTRA CLAIM FEES

			Extra Claims		Fee from below		Fee Paid
Total Claims	- **	=	0	X		=	0
Independent Claims	- **	=	0	X		=	0
Multiple Dependent				X		=	0

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	84	202	42	Independent claims in excess of 3
104	280	204	140	Multiple dependent claim, if not paid
109	84	209	42	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet.	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	410	216	205	Extension for reply within second month	
117	930	217	465	Extension for reply within third month	
118	1,450	218	725	Extension for reply within fourth month	
128	1,970	228	985	Extension for reply within fifth month	
119	320	219	160	Notice of Appeal	
120	320	220	160	Filing a brief in support of an appeal	320
121	280	221	140	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive – unavoidable	
141	1,300	241	650	Petition to revive – unintentional	
142	1,300	242	650	Utility issue fee (or reissue)	
143	470	243	235	Design issue fee	
144	630	244	315	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Processing fee under 37 CFR 1.17 (q)	
126	180	126	180	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	750	246	375	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	750	249	375	For each additional invention to be examined (37 CFR § 1.129(b))	
179	750	279	375	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify)

*Reduced by Basic Filing Fee Paid **SUBTOTAL (3)** ($) 320

SUBMITTED BY				Complete *(if applicable)*	
Name (Print/Type)	John P. Moran	*Registration No. Attorney/Agent)*	30,906	*Telephone*	202 424-7500
Signature	John P. Moran			*Date*	February 6, 2003

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